OPERATING INSTRUCTIONS

TYPE 1304-B

BEAT-FREQUENCY AUDIO GENERATOR

D.C.
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GENERAL RADIO COMPANY

670-1

SPECIFICATIONS

Frequency Range: 20 to 40,000 cycles in two ranges.

Frequency Controls: The main control is engraved from 20 to 20,000 cycles per second and has a true logarithmic frequency scale. The total scale length is approximately 12 inches. The effective angle of rotation is 240°, or 80° per decade of frequency. For the higher range, throwing a panel switch adds 20 kc to the scale frequency. The frequency increment dial is calibrated from +50 to −50 cycles.

Frequency Calibration: Within ± (1% + 0.5 cycle) after the oscillator has been correctly set to the line frequency or to zero beat. The 20 kc added by the range switch is accurate within ± 0.5%. Accuracy of frequency-increment dial is ± 1 cycle.

Zero-Beat Indicator: The output voltmeter is used to indicate zero beat.

Frequency Stability: The drift from a cold start is less than 7 cycles in the first hour and is essentially completed within two hours.

Output Voltmeter: Calibrated in volts output at open circuit, and in dbm. Above 10% of full scale the calibration is accurate within ± 5% of the reading.

Output Attenuator: Used only with single-ended output; has three steps of 20 db each, with an accuracy of ± 1% of the nominal attenuation.

Output Control: For each step of the attenuator the output voltage can be varied continuously from zero to the maximum voltage.

Output Voltage: Continuously variable from below 5 millivolts to 50 volts, open circuit. Full-scale, open circuit output voltages of 50 millivolts. 500 millivolts, 5 volts, and 50 volts are provided.

Frequency Characteristic: For a 600-ohm resistive load the variation of output voltage with frequency is as follows:

NORMAL Range, 20 to 20,000 c ± 0.25 db
ADD 20 KC Range, 20–30 kc, ± 0.5 db
30–40 kc, ± 1.0 db

For open-circuit operation the output voltage rises considerably at the higher frequencies.

Patent Nos 2,802,907; Re 24,204; 2,298,177

Output Impedance: 600 ohms, resistive, within ± 2%. At + 20 dbm setting of the output attenuator, the output may be used either balanced or with one side grounded. With one side of the output grounded, the attenuator may be used throughout its entire range.

Output Power: 1 watt, max., into a 600-ohm resistive load.

Harmonic Distortion: Less than 0.25% from 100 to 10,000 cycles. Below 100 cycles the harmonic content increases and may reach 0.5% at 50 cycles. Above 10,000 cycles the harmonic content is less than 1%.

AC Hum: Less than 0.1% of the output voltage for output voltmeter readings above 10% of full scale.

Terminals: TYPE 938 Binding Posts and standard Western Electric double output jack on panel: a standard four-terminal socket at the rear.

Mounting: Aluminum, 19-inch, relay-rack panel; aluminum cabinet. For table mounting (TYPE 1304-BM), aluminum end frames are supplied to fit ends of cabinet; for relay-rack mounting (TYPE 1304-BR), brackets for holding cabinet in rack are supplied. Relay-rack mounting is so arranged that panel and chassis can be removed from cabinet, leaving cabinet in rack, or cabinet can be removed from rear of rack, leaving panel attached to rack.

Power Supply: 105 to 125 (or 210 to 250) volts, 50 to 60 cycles. Power consumption is about 100 watts.

Power input receptacle will accept either 2-wire (TYPE CAP-35) or 3-wire (TYPE CAP-15) power cord. Two-wire cord is supplied. For 3-wire, see page 237.

Tube Complement:

2 — 6SL7-GT	1 — 6SA7
2 — 6AV5-GA	1 — 12AT7
2 — 0D3	1 — 5V4-G

Accessories Supplied: TYPE CAP-35 Power Cord, four-terminal plug, and spare fuses.

Dimensions: $19\frac{3}{8} \times 15\frac{1}{4} \times 7\frac{1}{4}$ inches,* over-all.

Net Weight: 39 pounds**

*(495 x 390 x 185 mm)

**18 kg

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OPERATING INSTRUCTIONS

TYPE 1304-B

BEAT-FREQUENCY AUDIO GENERATOR

Form 670-J
October, 1960

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

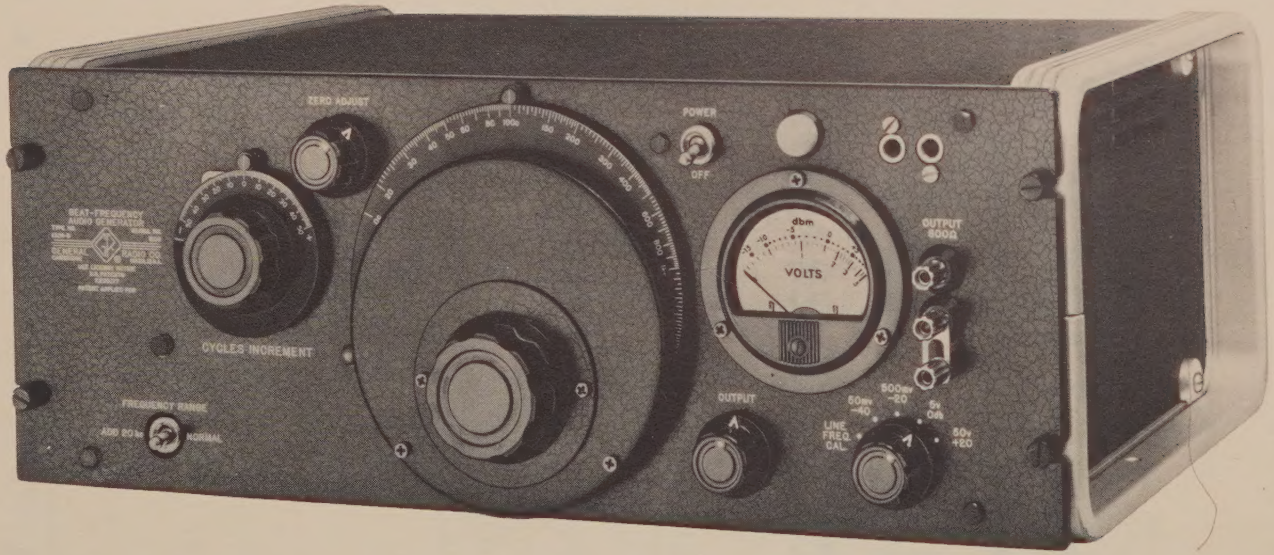


Figure 1. Panel View, Type 1304-B Beat-Frequency Audio Generator.

TYPE 1304-B BEAT-FREQUENCY AUDIO GENERATOR

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1304-B Beat-Frequency Audio Generator (Figure 1) is a signal generator capable of supplying up to 1 watt into a 600-ohm load at frequencies between 20 and 40,000 cycles per second. The Audio Generator is useful in amplitude-vs-frequency tests on audio-frequency equipment, and, as a general-purpose audio generator, is valuable as a power source for bridge measurements, as a modulator for r-f signal generators, and as a test source for acoustic work at both audio and ultrasonic frequencies. The Audio Generator can be coupled to an automatic analyzer or recorder.

1.2 DESCRIPTION.

1.2.1 GENERAL. The Audio Generator is mounted in a heavy-gauge aluminum cabinet, which is equipped with aluminum end frames for table use. If desired, the end frames can be removed and the instrument mounted in a 19-inch relay rack. Supplied with the Type 1304-BR (Relay-Rack Model) Audio Generator are special rack-mounting brackets, which secure cabinet and instrument to the rack, permitting either to be withdrawn independently of the other. Instructions for installing the Type 1304-BR in a relay rack accompany these brackets.

1.2.2 CONTROLS. The following controls are on the front panel of the Type 1304-B Beat-Frequency Audio Generator:

Name	Type	Function
CYCLES INCREMENT	Continuous rotary knob and dial	Permits small frequency variations above and below the main dial indication.
ZERO ADJUST	Continuous rotary knob	Varies frequency for calibration.

Continued

Name	Type	Function
Main tuning control	Continuous rotary knob and gear-driven logarithmic dial	Together with CYCLES INCREMENT and FREQUENCY RANGE controls, indicates frequency of output signal.
POWER	2-position toggle switch	Turns instrument on or off.
OUTPUT	Continuous rotary knob	Varies output voltage from zero to the maximum value for any attenuator setting.
FREQUENCY RANGE	2-position toggle switch	Selects either algebraic sum of main dial and CYCLES INCREMENT settings or this sum plus 20 kc.
Output attenuator	5-position rotary selector switch	Indicates output voltage when voltmeter is at full scale, indicates attenuation in dbm, and provides line-frequency calibration.

1.2.3 CONNECTIONS. The following connections are on the Type 1304-B Beat-Frequency Audio Generator:

Name	Type	Function
OUTPUT 600Ω	Jack-top binding posts (2)	Output terminals.
Ground	Jack-top binding post	Ground connection.
Output jack	Western Electric double output jack	Output terminals for Western Electric plugs.
Output socket	4-terminal socket	Output socket for 4-prong connectors.
Power	Fixed male connector	Accepts power plug and cord supplied.

1.2.4 METER. The panel voltmeter is calibrated in terms of open-circuit voltage, and the full-scale output is the value indicated by the attenuator switch setting. The meter also has a dbm (decibels above or below 1 milliwatt into a 600-ohm load) scale. To obtain the dbm value for a 600-ohm resistive load at the OUTPUT terminals, add the dbm reading algebraically to the attenuator decibel setting. Zero dbm is defined as 1 milliwatt dissipated in a resistance of 600 ohms, and corresponds to 0.775 volt across a 600-ohm load. (For a discussion of output impedance, refer to paragraph 3.5.)

1.3 ACCESSORIES. A power cord, four-terminal plug, and spare fuses are supplied with the instrument.

Section 2
OPERATING PROCEDURE

2.1 CONNECTION TO POWER SUPPLY. Connect the Audio Generator to a source of power as indicated on the metal plate at the power input socket, using the plug and cord provided. While instruments are normally supplied for 115-volt operation, power-transformer connections can be changed (see Figure 2) to convert to 230-volt operation. When changing connections, be sure to reverse the metal plate so that it will read 230 volts, and also replace the 1.25-amp line fuses with fuses rated at 0.6 amp.

2.2 GROUND CONNECTION. It is generally best to connect the panel ground terminal to an external ground in order to keep hum and noise to a minimum.

2.3 FREQUENCY CALIBRATION.

2.3.1 GENERAL. The frequency calibration can be standardized either at the power-line frequency or at zero. If the power-line frequency is controlled, standardization at line frequency is recommended.

Where maximum stability of calibration is desired, check the standardization occasionally during the first few minutes of operation and readjust if necessary. The frequency drift is less than seven cycles in the first hour of operation and is substantially complete after two hours.

2.3.2 ZERO-BEAT STANDARDIZATION.

a. Set the FREQUENCY RANGE switch to NORMAL.
b. Set the output attenuation switch to one of the db positions.
c. Adjust the OUTPUT control to give near full-scale indication on the meter.
d. Set the main dial and the CYCLES INCREMENT control to zero.
e. With the ZERO ADJUST control, vary the frequency until the meter pointer stops fluctuating and drops to zero.

2.3.3 LINE-FREQUENCY STANDARDIZATION.

a. Set the FREQUENCY RANGE switch to NORMAL.
b. Adjust the OUTPUT control for a midscale meter indication.
c. Set the output attenuator switch to the LINE FREQ CAL position.

d. Set the CYCLES INCREMENT dial to zero and the main dial to the line frequency.

e. Vary the frequency with the ZERO ADJUST control until the beat between the oscillator and power-line frequencies, as indicated by the fluctuation of the meter pointer, is as slow as possible. When the oscillator frequency is near the line frequency there is a large-amplitude fluctuation. At multiples of the line frequency small-amplitude fluctuations are obtained.

f. To determine that the adjustment was made at the correct beat, turn the output attenuator to a db position and make a rough check with zero beat.

2.4 LOAD. The Audio Generator is designed to operate into a load impedance of 600 ohms, but it can be operated into an open circuit without increased distortion. With the output attenuator switch set at +20 db, the harmonic content is approximately doubled when the generator is operated into a very low impedance. With the attenuator switch at any other position, the load impedance has no effect on the waveform.

When the output attenuator switch is set at +20 db and the ground strap is disconnected from the lower OUTPUT terminal, the output circuit is balanced well enough for operation into most audio-frequency equipment. Since the attenuation is inserted in only the lead connected to the upper OUTPUT terminal, the other attenuator positions should be used for only single-ended output.

In addition to the OUTPUT binding posts, two other sets of output terminals are provided. A Western-Electric-type double jack is provided in the upper right-hand corner of the front panel, and a four-terminal output socket is available in the rear lower left corner of the chassis. When a plug is inserted in the Western Electric output jack, all other output terminals are automatically disconnected. If one side of the load is grounded, connect that side to the right-hand jack. If the output attenuator is to be used in any position other than +20 db, connect the ground strap to the lower OUTPUT binding post.

Section 3

PRINCIPLES OF OPERATION

3.1 GENERAL. An elementary schematic diagram of the Audio Generator is given in Figure 3. The fixed oscillator delivers a signal of approximately either 190 or 210 kc to the mixer, where this signal is combined with a signal from the variable oscillator. The latter signal is variable from approximately 170 to 190 kc. The difference frequency,

which will lie between 0 to 20 or 20 to 40 kc, is fed to the amplifier input level control through a low-pass filter, which removes frequency components above 40 kc. The output of the amplifier is transformer-coupled to the output system. The complete schematic diagram, including power supply, is shown in Figure 2.

3.2 OSCILLATORS. Universal-wound coils on ceramic forms are used in the oscillator tuned circuits for maximum mechanical stability. The oscillator tubes are Type 6SL7-GT twin triodes, with the plate of the oscillator section grounded and the other section used as a cathode-follower isolating amplifier. With grounded plate operation of the oscillator, no tube shields are necessary to prevent capacitive coupling.

3.3 MIXER. The Type 6AS7 mixer tube operates with bias adjustments on grids 1 and 3. This permits adjustment of voltage and harmonic content of the output signal. A cylindrical magnetic shield reduces hum pickup from the power transformer's magnetic field when the instrument is in its cabinet.

3.4 AMPLIFIER. The low-distortion amplifier uses a single-ended push-pull output stage. One section of a Type 12AT7 twin triode drives the other section, which is connected as a phase inverter to drive the output stage in push-pull. The amplifier output is connected through a voltage divider to the cathode of the input amplifier tube to introduce negative feedback.

3.5 OUTPUT SYSTEM. The output system includes an output level control, an output transformer, a voltmeter, and an attenuator. The output level control, actually located at the input end of the amplifier, enables the amplifier input to be varied smoothly from zero to the level of the output from the low-pass filter.

An average-reading voltmeter, following the output transformer, uses two 1N54-A germanium crystal diodes in a full-wave rectifier circuit.

The resistive attenuator consists of two T-pads, which are switched to provide attenuation in 20-db steps from 0 to 60 db.

The output impedance of the Audio Generator is 600 ohms, if the source voltage is read from the voltmeter. The 600-ohm impedance consists of a 600-ohm series resistor, when the attenuator is set at the +20-dbm position; at all other attenuator positions, it consists of the 600-ohm resistor in combination with a 600-ohm attenuator network. The amplifier output impedance at the voltmeter is not zero, however, and load current through this impedance causes a drop in the meter reading when a load is connected across the output circuit after the 600-ohm series resistor. The amplifier output impedance varies with frequency and results in a meter-reading drop which varies from about 20% at low frequencies to about 50% at high frequencies, when a 600-ohm load is connected across the output circuit. Such a load is applied whenever the attenuator is switched to any position other than +20 dbm. With the

attenuator set at +20 dbm, connection of a load to the output terminals causes a drop in the meter reading, but at any other attenuator setting the output circuit is already loaded by the attenuator network, and connection of any additional load to the output terminals has practically no effect on the meter reading.

The amplifier output impedance at the voltmeter may be considered to be zero because the voltage at that point is indicated by the voltmeter and therefore is known. Thus the source impedance at the OUTPUT terminals can be considered a resistance of 600 ohms, the resistance between the voltmeter and the terminals. If a 600-ohm resistive load is connected to the OUTPUT terminals, the voltage at the load will be

$$\frac{600}{600 + 600}$$

or 1/2 of that indicated by the meter and attenuator switch setting. For other load impedances, this simple relation is expressed:

$$E_L = \frac{Z_L E_i}{Z_L + 600}$$

where:

E_L = voltage at the load

Z_L = load impedance

E_i = voltage indicated by meter and attenuator switch

In the calculation of voltage at the load, note that the indicated voltage is the voltage denoted by the meter and the attenuator switch after any initial drop as the load is connected.

Section 4

SERVICE AND MAINTENANCE

4.1 GENERAL. The two-year warranty given with every General Radio instrument attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible.

In case of difficulties that cannot be eliminated by the use of these service instructions, please write or phone our Service Department,

giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office (see back cover), requesting a Returned Material Tag. Use of this tag will insure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.2 READJUSTMENTS REQUIRED BY TUBE REPLACEMENT.

4.2.1 REPLACEMENT OF V1. Replacement of V1 may shift the zero-frequency adjustment beyond the range of the panel control. To readjust, proceed as follows:

a. Set the main dial and the CYCLES INCREMENT dial to zero.

b. Set the ZERO ADJUST knob so that the pointer points upward.

c. Throw the FREQUENCY RANGE switch to NORMAL.

d. With a small screwdriver, adjust C7 (on the oscillator casting, just behind the panel) to obtain zero beat.

4.2.2 REPLACEMENT OF V2. Replacement of V2 may also shift the zero-frequency adjustment beyond the range of the panel control. To readjust, proceed as follows:

a. Set the controls as described in paragraph 4.2.1, steps a through c.

b. Adjust C16 (on the oscillator casting, just behind the panel) to obtain zero beat.

4.2.3 REPLACEMENT OF V3. Replacement of V3 may affect the output level and the harmonic and hum content. To readjust, proceed as follows:

a. Connect a 600-ohm load in parallel with a wave analyzer across the OUTPUT terminals.

b. Set the output frequency to 1000 cycles, and set the output attenuator switch to +20 db.

c. Turn the OUTPUT level control to its maximum clockwise position, and adjust R12 (under the chassis on the rear of the oscillator casting) to give a reading of slightly over 5 volts on the panel meter.

d. Set the meter indication to about 0.2 volt with the output level control, and adjust R11 (under the chassis on the rear of the oscillator casting) for a minimum second harmonic (2000 cycles) in the output.

e. Check the level, and, if necessary, repeat both adjustments.

f. Increase the output to maximum, and adjust the wave analyzer to measure the 60-cycle content in the output.

g. Adjust R56 (on the top of the power-supply shelf near the power transformer) to obtain a minimum reading on the analyzer. The 60-cycle content should be less than 0.1 percent of the 1000-cycle output voltage. If necessary, select the replacement tube to reduce the hum to this level. Be sure to replace the cylindrical magnetic shield on the new tube.

4.2.4 REPLACEMENT OF V4 OR V6. Replacement of V4 or V6 may make it necessary to readjust the bias voltage on the control grids of these tubes. To readjust, proceed as follows:

a. Turn the OUTPUT level control to zero (maximum counter-clockwise position).

b. Adjust the biases of V4 and V6 to -17 volts, measured between grid and cathode of each tube with a voltmeter of high input impedance. Use R28 (under the chassis on the side of the amplifier shelf) for the V4 adjustment, and R32 (on the top of the power-supply shelf near the power transformer) for V6. The adjustments are somewhat interdependent, and may have to be repeated.

4.2.5 REPLACEMENT OF VOLTMETER DIODES. If it should ever be necessary to replace either or both of the voltmeter diodes, D1 and D2, the calibration of the voltmeter should be checked, and adjusted if necessary. To adjust, proceed as follows:

a. Turn the output attenuator switch to +20 db.

b. Connect an accurate, high-impedance voltmeter (100 kilohms or higher) across the OUTPUT terminals.

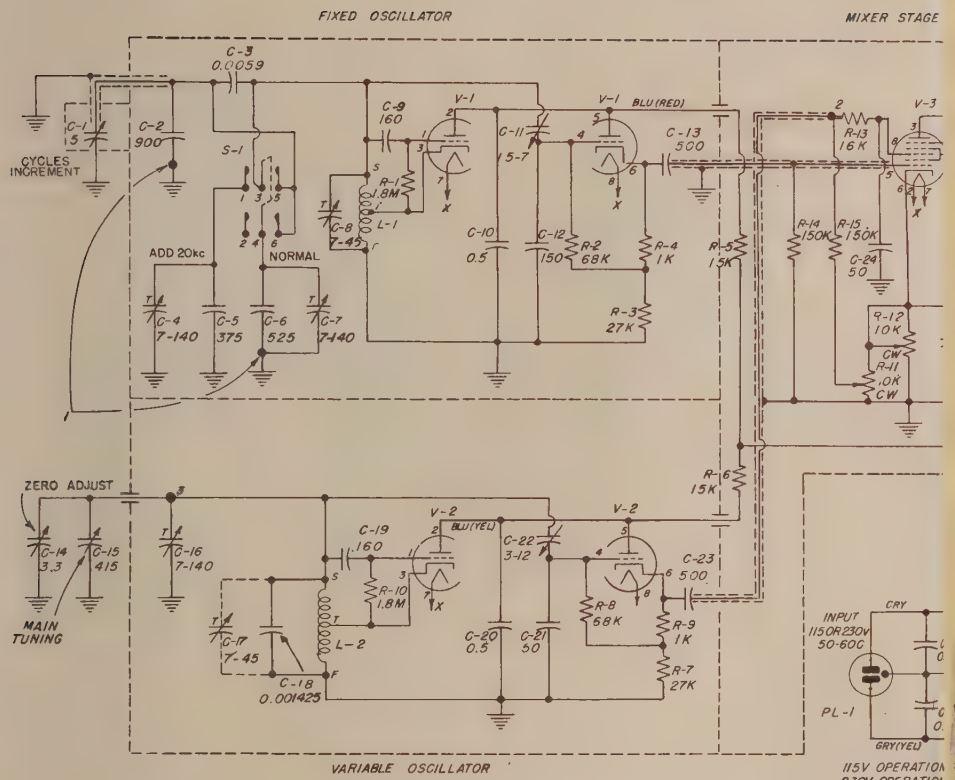
c. Readjust calibration by means of R36 (under the chassis on the amplifier shelf).

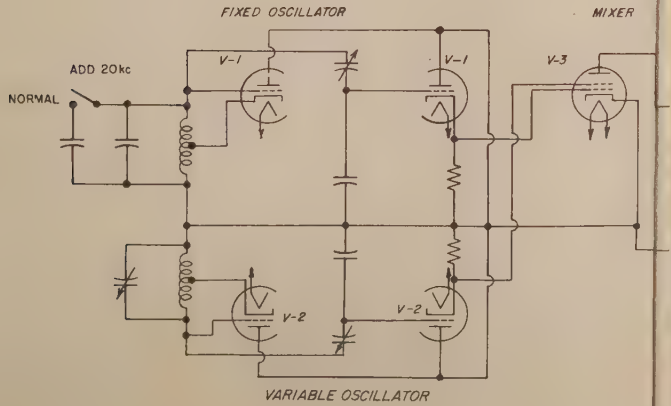
Table Of Voltages And Resistances

TUBE TYPE	PIN	VOLTS TO GND	RES TO GND
V1, V2 (6SL7GT)	1	--	1.8 M
	2	260	15 k
	3	0	0.5
	4	46.5	115 k
	5	260	15 k
	6	48	28 k
	7	58	66 k
	8	58	66 k
V3 (6SA7)	1	0	0
	2	58	66 k
	3	260	76 k
	4	90	75 k
	5	0	150 k
	6	7.0	15 k
	7	58	66 k
	8	3.0	170 k
V4 (6AV5)	1	133	680 k
	2	58	66 k
	3	150	55 k
	5	290	0
	7	58	66 k
	8	288	150
V5 (12AT7)	1	115	100 k
	2	0	1 M
	3	1.7	1 k
	4	58	66 k
	5	58	66 k
	6	140	20 k
	7	19	2.2 M
	8	21.5	19.8 k
	9	58	66 k
V6 (6AV5)	1	0	560 k
	2	58	66 k
	3	17	200
	5	150	56 k
	7	58	66 k
	8	149	56 k
V7 (OD3)	2	0	0
	5	150	∞
V8 (OD3)	2	150	∞
	5	300	0
V9 (5V4G)	2	380	1 k
	4	360 ac	108
	6	360 ac	100
	8	380	1 k

Notes

(1) Input resistance of dc voltmeter must be several times the value listed in the resistance column, to avoid loading errors.
(2) Both panel OUTPUT controls must be set fully clockwise.
(3) Volts are dc unless otherwise stated.
(4) Resistance is in ohms unless otherwise indicated by k (kilohms) or M (megohms).
(5) Resistance measurements should be made with power disconnected, and with pin 5 of V4 and pin 5 of V8 grounded to the chassis.


FIXED OSCILLATOR
MIXER STAGE
C-3 0.0059
C-1 5
C-2 900
CYCLES INCREMENT
S-1
ADD 20kc
NORMAL
C-4 7-140
C-5 375
C-6 525
C-7 7-140
C-8 7-45
L-1
C-9 160
R-1 1.8M
V-1
C-11 5-7
C-10 0.5
C-12 150
R-2 68K
R-4 1K
R-3 27K
R-5 15K
V-1 BLU(RED)
C-13 500
V-3
R-13 16K
R-14 150K
R-15 150K
C-24 50
R-12 10K
R-11 .01K CW
R-6 15K
ZERO ADJUST
C-14 3.3
C-15 415
C-16 7-140
MAIN TUNING
C-17 7-45
C-18 0.001425
L-2
C-19 160
R-10 1.8M
V-2
BLU(YEL)
C-22 3-12
C-20 0.5
C-21 50
R-8 68K
R-9 1K
R-7 27K
C-23 500
INPUT 115OR230V 50-60C
CRY
PL-1
GRY(YEL)
115V OPERATION
230V OPERATION
VARIABLE OSCILLATOR


FIXED OSCILLATOR
MIXER
ADD 20kc
NORMAL
V-1
V-1
V-3
V-2
V-2
VARIABLE OSCILLATOR

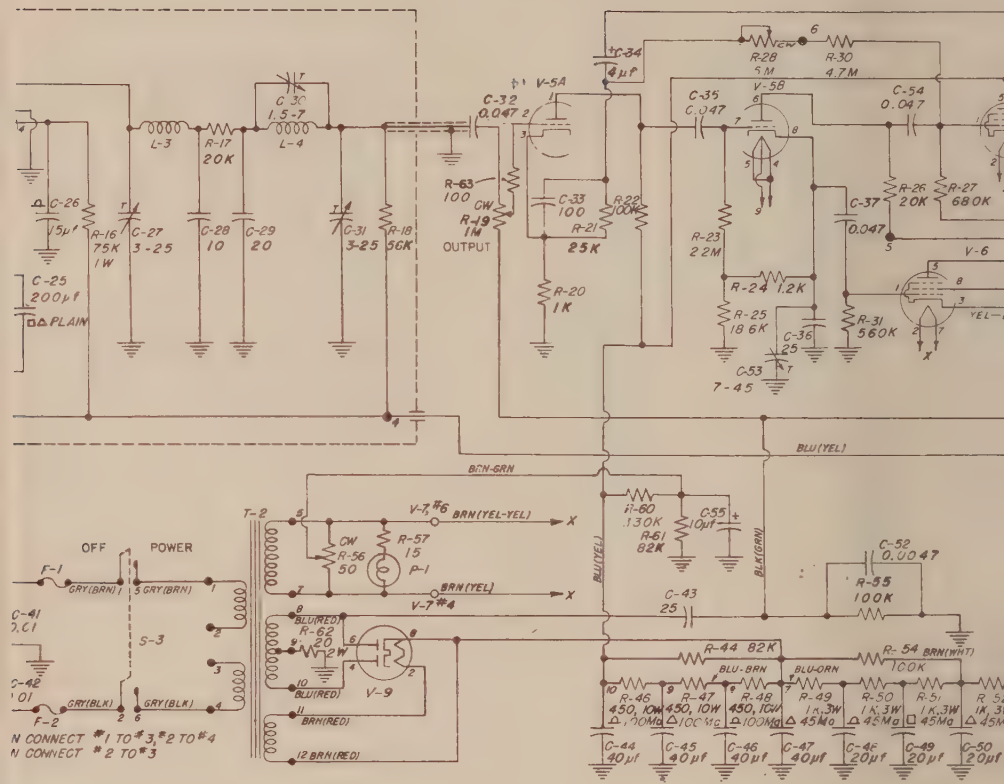


Figure 2. Detailed Schematic Diagram.

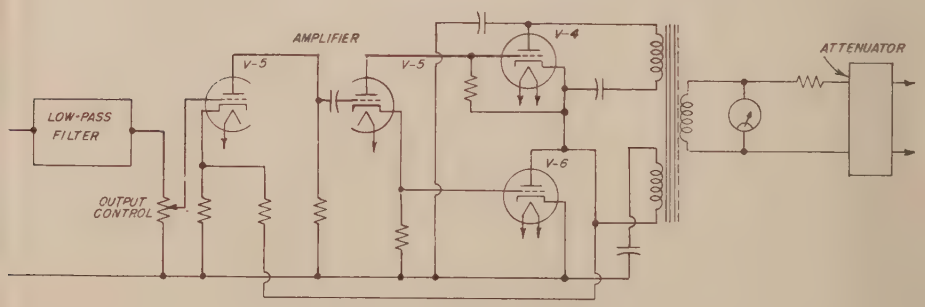
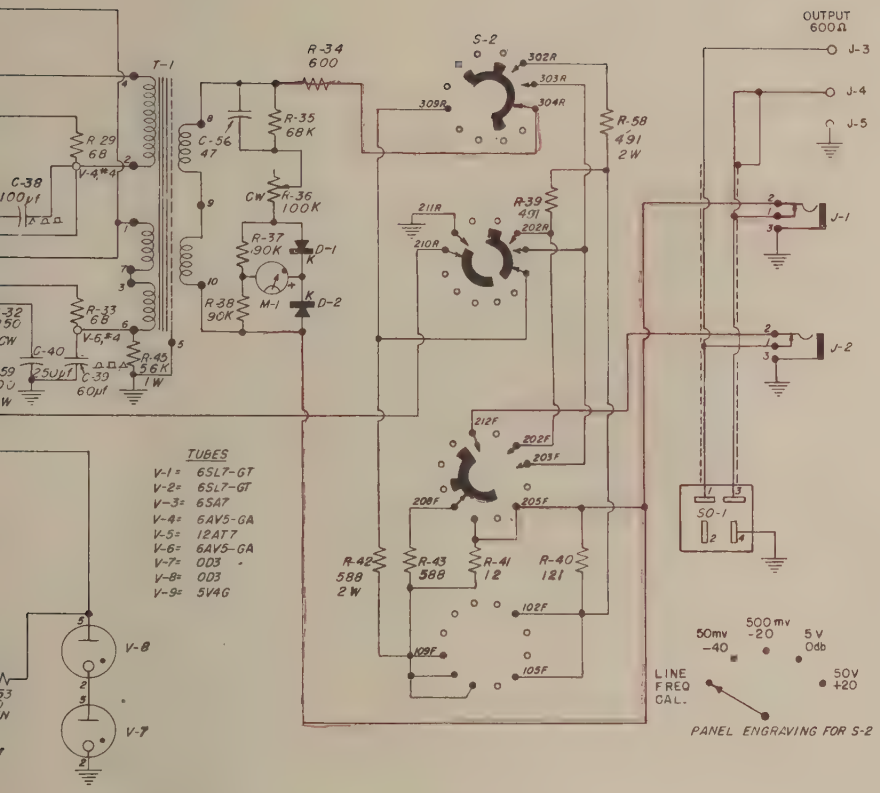


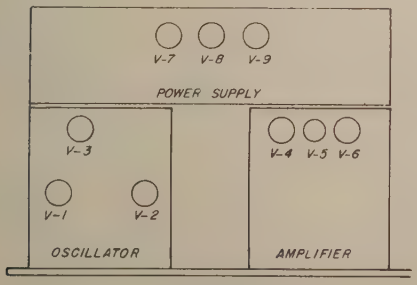
Figure 3. Elementary Schematic Diagram and Tube Location Diagram.



TUBES

V-1 =	6SL7-GT
V-2 =	6SL7-GT
V-3 =	6SA7
V-4 =	6AV5-GA
V-5 =	12AT7
V-6 =	6AV5-GA
V-7 =	OD3
V-8 =	OD3
V-9 =	5V4G

NOTES: RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K = 1000 OHMS M = 1 MEGOHM
CAPACITANCE VALUES ONE AND OVER IN MICRO-MICROFARADS,
LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED



TOP VIEW
OF
VACUUM TUBE LAYOUT

RESISTORS (NOTE B)

REF				GR NO. (NOTE A)
R1	1.8M	±10%	1/2w	REC-20BF
R2	68k	±10%	1/2w	REC-20BF
R3	27k	±10%	1/2w	REC-20BF
R4	1.0k	±10%	1/2w	REC-20BF
R5	15k	±10%	1/2w	REC-20BF
R6	15k	±10%	1/2w	REC-20BF
R7	27k	±10%	1/2w	REC-20BF
R8	68k	±10%	1/2w	REC-20BF
R9	1.0k	±10%	1/2w	REC-20BF
R10	1.8k	±10%	1/2w	REC-20BF
R11	10k	±10%		POSC-11
R12	10k	±10%		POSC-11
R13	16k	± 5%	1/2w	REC-20BF
R14	150k	±10%	1/2w	REC-20BF
R15	150k	±10%	1/2w	REC-20BF
R16	75k	± 5%	1w	REC-30BF
R17	20k	± 5%	1/2w	REC-20BF
R18	56k	± 5%	1/2w	REC-20BF
R19	1M	±20%		POSC-12
R20	1k	± 1%	1/2w	REF-70
R21	25k	± 1%	1/2w	REF-70
R22	100k	±10%	1/2w	REC-20BF
R23	2.2M	±10%	1/2w	REC-20BF
R24	1.2k	± 1%	1/2w	REF-70
R25	18.6k	± 1%	1/2w	REF-70
R26	20k	± 1%	1/2w	REF-70
R27	680k	±10%	1/2w	REC-20BF
R28	5M	±20%		POSC-11
R29	68	±10%	1/2w	REC-20BF
R30	4.7M	±10%	1/2w	REC-20BF
R31	0.56M	±10%	1/2w	REC-20BF
R32	250	±10%		POSW-3
R33	68	±10%		REC-20BF
R34	600	± 1%	5w	REF-1-4
R35	68k	±10%	1/2w	REC-20BF
R36	100k	±10%		POSC-11
R37	90k	± 1%	1/2w	REF-65
R38	90k	± 1%	1/2w	REF-65
R39	491	± 1%	1/2w	REF-70
R40	121	± 1%	1/2w	REF-70
R41	12	± 1%	1/2w	REF-70
R42	588	± 1%	2w	REF-1-3
R43	588	± 1%	1/2w	REF-70
R44	82k	±10%	1/2w	REC-20BF
R45	56k	±10%	1w	REC-30BF
R46	450	+5%	10w	REPO-44
R47	450	+5%	10w	REPO-44
R48	450	+5%	10w	REPO-44
R49	1k	±5%	3w	REPO-45
R50	1k	±5%	3w	REPO-45
R51	1k	±5%	3w	REPO-45
R52	1k	+5%	3w	REPO-45
R53	120	±10%	1/2w	REW-3C
R54	100k	±10%	1/2w	REC-20BF
R55	100k	±10%	1/2w	REC-20BF
R56	50	±10%		POSW-3
R57	15	±10%	1/2w	REW-3C
R58	491	± 1%	2w	REF-1-3
R59	100	±10%	1w	REW-4C
R60	330k	±10%	1/2w	REC-20BF
R61	82k	±10%	1/2w	REC-20BF
R62	20	±10%	2w	REW-6C
R63	100	±10%	1/2	REC-20BF

CAPACITORS

REF		GR NO. (NOTE A)
C1	5μμf	368-413
C2	900μμf ±1%	COM-5F
C3	0.0059μf ±1%	COM-1F
C4	7-140μμf	COA-5L
C5	375μμf ±1%	COM-5F
C6	525μμf ±1%	COM-5F
C7	7-140μμf	COA-5
C8	7-45μμf	COT-12
C9	160μμf ±10%	COM-20B
C10	0.5μf ±10%, 600dcwv	COL-44
C11	1.5-7μμf	COT-17
C12	150μμf ±10%	COM-20E
C13	500μμf ±10%	COM-20B
C14	3.3μμf	846-404
C15	415μμf	539-410-4
C16	7-140μμf	COA-5
C17	7-45μμf	COT-12
C18★	0.001425μf ±1%	COM-5F
C19	160μμf ±10%	COM-20B
C20	0.5μf ±10%, 600dcwv	COL-44
C21	50μμf ±10%	COM-20B
C22	3-12μμf	COT-23
C23	500μμf ±10%	COM-20B
C24	50μμf ±10%	COM-20B
C25	200μf +100%-10%, 25dcwv	COEB-8
C26	15μf +100%-10%, 450dcwv	
C27	3-25μμf	COA-1
C28	10μμf ±5%	COM-20B
C29	20μμf ±5%	COM-20B
C30	1.5-7μμf	COT-17
C31	3-25μμf	COA-1
C32	0.047μf ±10%, 600dcwv	COL-71
C33	100μμf ±2%	COM-20E
C34	4μf +100%-10%, 450dcwv	COE-19
C35	0.047μf ±10%, 600dcwv	COC-71
C36	25μμf ±10%	COM-20B
C37	0.047μf ±10%, 400dcwv	COW-25
C38	100μf +100%-10%, 350dcwv	COEB-35
C39	60μf +100%-10%, 450dcwv	COEB-36
C40	250μf +100%-10%, 25dcwv	
C41	0.41μf ±10%, 600dcwv	COL-71
C42	0.01μf ±10%, 600dcwv	COL-71
C43	25μμf ±10%	COM-20B
C44	40μf +100%-10%, 450dcwv	COEB-17
C45	40μf +100%-10%, 450dcwv	
C46	40μf +100%-10%, 450dcwv	COEB-17
C47	40μf +100%-10%, 450dcwv	
C48	20μf +100%-10%, 450dcwv	
C49	20μf +100%-10%, 450dcwv	COEB-25
C50	20μf +100%-10%, 450dcwv	
C51	20μf +100%-10%, 450dcwv	
C52	0.0047μf ±10%, 600dcwv	COL-71
C53	7-45μμf	COT-12
C54	0.047μf ±10%, 400dcwv	COW-25
C55	10μf +100%-10%, 250dcwv	COE-33
C56	47μμf ±10%	COM-20B

	REF		GR NO. (NOTE A)
MISCELLANEOUS	D1	DIODE	1N54-A
	D2	DIODE	1N54-A
	F1	FUSE, 1.25 amp Slo-Blo Type 3AG (for 115v)	FUF-1
	F1	FUSE, 0.6 amp Slo-Blo Type 3AG (for 230v)	FUF-1
	F2	FUSE, 1.25 amp Slo-Blo Type 3AG (for 115v)	FUF-1
	F2	FUSE, 0.6 amp Slo-Blo Type 3AG (for 230v)	FUF-1
	L1	INDUCTOR	1304-204
	L2	INDUCTOR	1304-204
	L3	INDUCTOR, 250mh +5%	119-30
	L4	INDUCTOR, 250mh +5%	119-30
	M1	METER, 0-200μa	MEDS-102
	P1	PILOT LIGHT, Mazda Type 44	2LAP-939
	S1	SWITCH, dpdt	SWT-335A, NP
	S2	SWITCH, 5-position	SWRW-76
	S3	SWITCH, dpst	SWT-333, NP
	T1	TRANSFORMER	485-478
	T2	TRANSFORMER	365-417-3
	V1	TUBE	6SL7-GT
	V2	TUBE	6SL7-GT
	V3	TUBE	6SA7
	V4	TUBE	6AV5-GA
	V5	TUBE	12AT7
	V6	TUBE	6AV5-GA
	V7	TUBE	OD3
	V8	TUBE	OD3
	V9	TUBE	5V4G

NOTES

(A) GR Type designations are as follows:

COA - Capacitor, air
COE - Capacitor, electrolytic
COEB - Capacitor, electrolytic block
COL - Capacitor, oil
COM - Capacitor, mica
COT - Capacitor, trimmer
COW - Capacitor, wax
POSC - Potentiometer, composition
POSW - Potentiometer, wire-wound
REC - Resistor, composition
REF - Resistor, film
REPO - Resistor, power
REW - Resistor, wire-wound

(B) All resistances are in ohms except as otherwise indicated by k (kilohms) or M (megohms).

★ One 900μμf ±1%, COM-5F and one 525μμf ±1%, COM-5F in parallel.

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